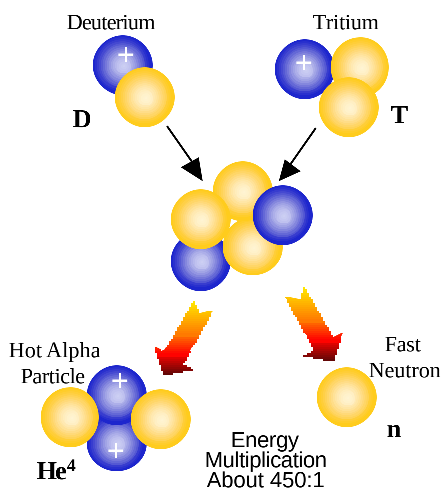
Office of Science

Fusion Energy Sciences

http://www.ofes.science.doe.gov

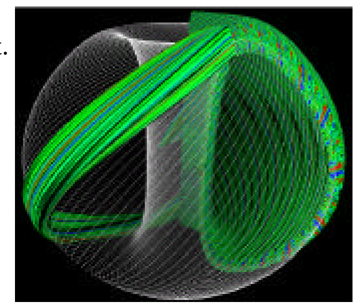
The Office of Science's Fusion Energy Sciences Program leads the nation's effort in the study of plasma, the fourth state of matter, which constitutes most of the visible universe, and is at the core of a fusion power system.



Fusion Reaction

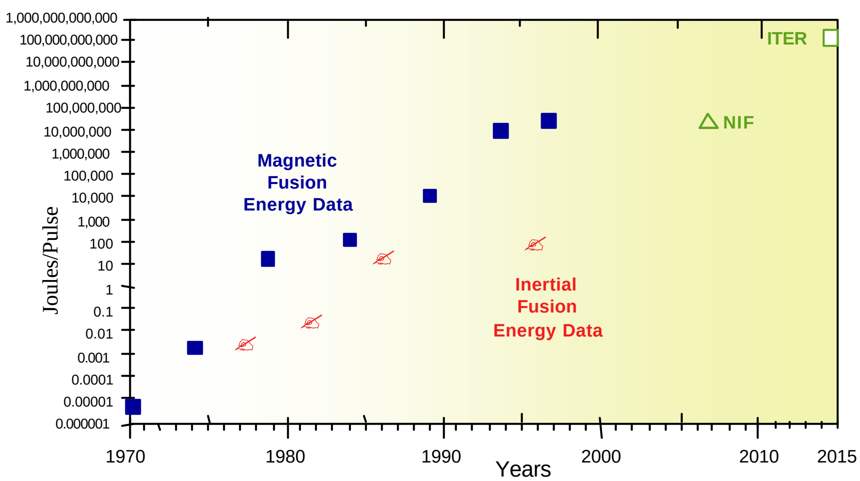
The Opportunity: Fusion is the power source of the sun and the stars. It occurs when forms of the lightest atom, hydrogen, combine to make helium in a very hot (100 million degree centigrade) ionized gas, or plasma. A small amount of matter involved in the reaction is converted to a large amount of energy. When developed, fusion will provide a virtually inexhaustible, safe, environmentally benign, and affordable energy source. Its fundamental fuel, from seawater, is readily available to all nations.

The Challenge: We now have high confidence that it will be possible to design and build a fusion power plant. The major challenge today is to make fusion energy practical by further advancing our scientific understanding of high-temperature plasmas. This science-based approach focuses on achieving a predictive capability based on detailed experimental campaigns, sophisticated modeling, and terascale computing. Dramatic advances in the scientific understanding of fusion plasmas have been achieved using the Department's advanced computing capability. Efforts to upgrade codes and enhance scientific diagnostic capabilities will be key to further advances, as well as access to more powerful computers.



Advanced Scientific Computing in Fusion Energy Science

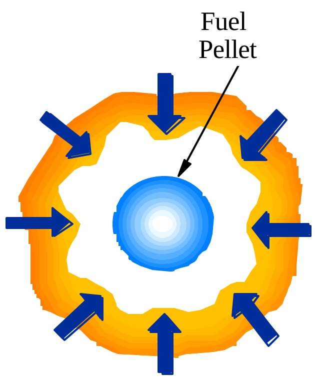
There are two distinct approaches to producing fusion energy. In magnetic fusion energy (MFE), the plasma is confined by a magnetic field and held at the required density and temperature. The fusion energy produced in an individual magnetic confinement fusion experiment has risen by a factor of more than one trillion during the time period when computer speed has risen by a factor of one-hundred thousand (see graph). Along with this progress in fusion energy has come much deeper understanding of the underlying plasma science.



Progress in Fusion Energy Production

To date, MFE has been the primary subject of research worldwide for fusion energy applications. Consequently, the U.S. fusion program is highly leveraged against more than $1 billion in magnetic fusion research performed by other nations. Magnetic Fusion research is an international effort in which experimental results are openly shared and in which collaboration on experiments is extensive.

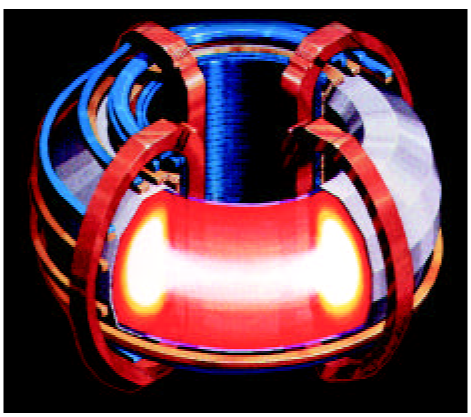
To achieve inertial fusion energy (IFE), powerful lasers or particle beams are focused on a small pellet of fuel for a few billionths of a second. IFE research has been pursued primarily as a key component of the Department of Energy's Stockpile Stewardship Program. Leveraging off this large investment is an excellent opportunity, for IFE may also present a promising path to practical fusion power. The MFE and IFE scientific communities are working together closely and have created a research plan with key assessment points in 5, 10, and 15 years. If adequately funded and implemented, the plan will deliver essential progress in key scientific and technological areas, positioning the fusion program to make critical choices about the next phase of the U.S. fusion research program.



Inertial Fusion Energy Concept

Investment Plan: The MFE/IFE research plan was developed by the Fusion Energy Sciences Advisory Committee (FESAC). As detailed in the FESAC report, research is carried out in several thrust areas.

- Basic plasma science and computational programs,
- Innovative experiments to broaden the science base and perhaps make fusion more practical;
- Upgrading and operating major experiments to address fusion and plasma science issues;
- Research on how inertial fusion leads to practical energy; and
- A fusion technology program in support of fusion science experiments and the longer term needs of fusion energy.



Magnetic Fusion Energy Concept

The Benefits: The science-based approach to fusion offers the most expeditious path to the fusion energy objective and is advancing our knowledge of plasma physics and associated technologies, yielding near-term benefits in a broad range of disciplines. Examples include plasma processing of semiconductor chips for computers and other electronic devices, advanced video displays, innovative materials coatings, the efficient destruction of chemical and radioactive wastes, and more efficient space propulsion.

The full implementation of the FESAC recommendations will result in a robust and productive fusion energy sciences program.